

## IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

- 1           1.       (Withdrawn) A method for forming a differential GMR sensor,  
2    comprising:  
3           forming a first shield and first gap layer;  
4           forming a first self-pinned GMR sensor having a first pinned layer, a first spacer  
5    layer and a first free layer;  
6           forming a bias structure over the first free layer, wherein the bias structure is  
7    formed to provide antiparallel magnetizations for the first and second free layers without  
8    using an antiferromagnetic layer; and  
9           forming a second self-pinned GMR sensor having a second pinned layer, a second  
10   spacer layer and a second free layer.
- 1           2.       (Withdrawn) The method of claim 1, wherein the forming the bias  
2    structure further comprises forming four ferromagnetic layers separated with three  
3    interlayers selected to provide a desired gap length.
- 1           3.       (Withdrawn) The method of claim 1, wherein the forming the bias  
2    structure further comprises forming four ferromagnetic layers separated with three  
3    interlayers.
- 1           4.       (Withdrawn) The method of claim 3, wherein the forming four  
2    ferromagnetic layers further comprises forming four NiFe layers.

1           5.       (Withdrawn) The method of claim 4, wherein the forming four NiFe  
2 layers further comprises forming four NiFe layers having a nickel composition of 90%.

1           6.       (Withdrawn) The method of claim 3, wherein the forming four  
2 ferromagnetic layers separated with three interlayers further comprises forming three  
3 interlayer comprises ruthenium.

1           7.       (Withdrawn) The method of claim 1, wherein the forming the bias  
2 structure further comprises forming the bias structure with a layer of tantalum, a layer of  
3 aluminum oxide, a layer of nickel-iron-chromium and a layer of oxine copper.

1           8.       (Withdrawn) The method of claim 7, wherein the forming the layer of  
2 aluminum oxide further comprises a layer of aluminum oxide having a thickness selected  
3 to minimize current shunting.

1           9.       (Withdrawn) The method of claim 1, wherein the forming a first self-  
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer  
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second  
4 spacer layer and a second free layer further comprises forming the first and second free  
5 layer using a first free sublayer, an interlayer and a second free sublayer.

1           10.     (Withdrawn) The method of claim 9, wherein the forming the first and  
2     second free layer further comprises biasing the first and second free layer 180° out of  
3     phase.

1           11.     (Withdrawn) The method of claim 10, wherein the biasing the first and  
2     second free layer 180° out of phase further comprises using in-phase pinned layers.

1           12.     (Withdrawn) The method of claim 1, wherein the forming a first self-  
2     pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer  
3     and forming a second self-pinned GMR sensor having a second pinned layer, a second  
4     spacer layer and a second free layer further comprises forming self-pinned pinned layers.

1           13.     (Withdrawn) The method of claim 1, wherein the forming a first self-  
2     pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer  
3     and forming a second self-pinned GMR sensor having a second pinned layer, a second  
4     spacer layer and a second free layer further comprises forming the first and second  
5     pinned layers with antiparallel magnetizations to provide a net magnetostatic bias of zero  
6     for the first and for the second pinned layers.

1           14.     (Withdrawn) The method of claim 1, wherein the forming a first self-  
2     pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer  
3     and forming a second self-pinned GMR sensor having a second pinned layer, a second  
4     spacer layer and a second free layer further comprises forming the first pinned layer using  
5     three ferromagnetic layers..

1           15.     (Withdrawn) The method of claim 1, wherein the forming a first self-  
2     pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer  
3     and forming a second self-pinned GMR sensor having a second pinned layer, a second  
4     spacer layer and a second free layer further comprises forming a bottom pinned layer  
5     using a first top ferromagnetic layer, a first spacer and a first bottom ferromagnetic layer  
6     and forming a top pinned layer using a second top ferromagnetic layer, a second spacer  
7     and a second bottom magnetic layer.

1           16.     (Withdrawn) The method of claim 15, wherein the forming the first  
2     bottom ferromagnetic layer and the second top ferromagnetic layer are formed using a  
3     high field reset.

1           17.     (Withdrawn) The method of claim 15, wherein the forming the first top  
2     ferromagnetic layer and the second bottom ferromagnetic layer are formed having a  
3     magnetization 180° out of phase.

1           18.     (Currently Amended) A differential GMR sensor, comprising:  
2           a first self-pinned GMR sensor having a first pinned layer, a first spacer layer and  
3           a first free layer;  
4           ~~a bias structure over the first free layer, wherein the bias structure is formed to~~  
5           ~~provide antiparallel magnetizations for the first and second free layers without using an~~  
6           ~~antiferromagnetic layer; and~~  
7           a second self-pinned GMR sensor having a second pinned layer, a second spacer  
8           layer and a second free layer; and  
9           a bias structure disposed between the first free layer of the first self-pinned GMR  
10          sensor and the second free layer of the second self-pinned GMR sensor, wherein the bias  
11          structure is configured to provide antiparallel magnetizations for the first and second free  
12          layers without using an antiferromagnetic layer.

1           19.     (Currently Amended) The sensor of claim 18, wherein the bias structure  
2           further comprises four ferromagnetic layers separated with three interlayers selected to  
3           provide a desired gap length.

1           20.     (Original)     The sensor of claim 18, wherein the bias structure further  
2           comprises four ferromagnetic layers separated with three interlayers.

1           21.     (Currently Amended) The sensor of claim 20, wherein the four  
2           ferromagnetic layers further ~~[[ comprises ]]~~ comprise four NiFe layers.

1           22.     (Currently Amended) The sensor of claim 21, wherein the four NiFe [[  
2     comprises ]] comprise a nickel composition of 90%.

1           23.     (Currently Amended) The sensor of claim 20, wherein the three  
2     interlayers further [[ comprises ]] comprise ruthenium.

1           24.     (Withdrawn) The sensor of claim 18, wherein the bias structure further  
2     comprises a layer of tantalum, a layer of aluminum oxide, a layer of nickel-iron-  
3     chromium and a layer of oxine copper.

1           25.     (Withdrawn) The sensor of claim 24, wherein the layer of aluminum  
2     oxide further comprises a thickness selected to minimize current shunting.

1           26.     (Withdrawn) The sensor of claim 18, wherein the first and second free  
2     layer each further comprises a first free sublayer, an interlayer and a second free sublayer.

1           27.     (Withdrawn) The sensor of claim 26, wherein the first and second free  
2     layer are biased 180° out of phase.

1           28.     (Withdrawn) The sensor of claim 27, wherein the first and second free  
2     layer are biased 180° out of phase using in-phase pinned layers.

1           29.     (Withdrawn) The sensor of claim 18, wherein the first pinned layer and  
2     second pinned layer further comprises self-pinned pinned layers.

1           30.     (Withdrawn) The sensor of claim 18, wherein the first and second pinned  
2 layers further comprises antiparallel magnetizations for providing a net magnetostatic  
3 bias of zero for the first and for the second pinned layers.

1           31.     (Withdrawn) The sensor of claim 18, wherein the first pinned layer  
2 further comprises three ferromagnetic layers.

1           32.     (Withdrawn) The sensor of claim 18, wherein the first pinned layer  
2 comprises a bottom pinned layer having a first top ferromagnetic layer, a first spacer and  
3 a first bottom ferromagnetic layer and the second pinned layer comprises a top pinned  
4 layer having a second top ferromagnetic layer, a second spacer and a second bottom  
5 magnetic layer.

1           33.     (Withdrawn) The sensor of claim 32, wherein the first top ferromagnetic  
2 layer and the second bottom ferromagnetic layer have a magnetization 180° out of phase.

1           34.     (Currently Amended) A magnetic disk recording system, comprising:  
2           a magnetic storage medium having a plurality of tracks for recording of data; and  
3           a magnetic transducer maintained in a closely spaced position relative to the  
4     magnetic storage medium during relative motion between the magnetic transducer and  
5     the magnetic storage medium, the magnetic transducer including a magnetoresistive read  
6     sensor, the magnetoresistive read sensor further comprising:

7                     a first self-pinned GMR sensor having a first pinned layer, a first spacer  
8     layer and a first free layer;

9                     ~~a bias structure over the first free layer, wherein the bias structure is~~  
10    ~~formed to provide antiparallel magnetizations for the first and second free layers without~~  
11    ~~using an antiferromagnetic layer; and~~

12                     a second self-pinned GMR sensor having a second pinned layer, a second  
13    spacer layer and a second free layer; and

14                     a bias structure disposed between the first free layer of the first self-pinned  
15    GMR sensor and the second free layer of the second self-pinned GMR sensor, wherein  
16    the bias structure is configured to provide antiparallel magnetizations for the first and  
17    second free layers without using an antiferromagnetic layer.

1           35.     (Currently Amended) The magnetic disk recording system of claim 34,  
2     wherein the bias structure further comprises four ferromagnetic layers separated with  
3     three interlayers selected to provide a desired gap length.



1           36.     (Original)     The magnetic disk recording system of claim 34, wherein  
2     the bias structure further comprises four ferromagnetic layers separated with three  
3     interlayers.

1           37.     (Currently Amended) The magnetic disk recording system of claim 36,  
2     wherein the four ferromagnetic layers further [[ comprises ]] comprise four NiFe layers.

1           38.     (Currently Amended) The magnetic disk recording system of claim 37,  
2     wherein the four NiFe [[ comprises ]] comprise a nickel composition of 90%.

1           39.     (Currently Amended) The magnetic disk recording system of claim 36,  
2     wherein the three interlayers further [[ comprises ]] comprise ruthenium.

1           40.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the bias structure further comprises a layer of tantalum, a layer of aluminum oxide, a  
3     layer of nickel-iron-chromium and a layer of oxine copper.

1           41.     (Withdrawn) The magnetic disk recording system of claim 40, wherein  
2     the layer of aluminum oxide further comprises a thickness selected to minimize current  
3     shunting.

1           42.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the first and second free layer each further comprises a first free sublayer, an interlayer  
3     and a second free sublayer.

1           43.     (Withdrawn) The magnetic disk recording system of claim 42, wherein  
2     the first and second free layer are biased 180° out of phase.

1           44.     (Withdrawn) The magnetic disk recording system of claim 43, wherein  
2     the first and second free layer are biased 180° out of phase using in-phase pinned layers.

1           45.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the first pinned layer and second pinned layer further comprises self-pinned pinned  
3     layers.

1           46.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the first and second pinned layers further comprises antiparallel magnetizations for  
3     providing a net magnetostatic bias of zero for the first and for the second pinned layers.

1           47.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the first pinned layer further comprises three ferromagnetic layers.

1           48.     (Withdrawn) The magnetic disk recording system of claim 34, wherein  
2     the first pinned layer comprises a bottom pinned layer having a first top ferromagnetic  
3     layer, a first spacer and a first bottom ferromagnetic layer and the second pinned layer  
4     comprises a top pinned layer having a second top ferromagnetic layer, a second spacer  
5     and a second bottom magnetic layer.

1           49.     (Withdrawn) The magnetic disk recording system of claim 48, wherein  
2     the first top ferromagnetic layer and the second bottom ferromagnetic layer have a  
3     magnetization 180° out of phase.

1           50.     (Currently Amended) A differential GMR sensor, comprising:  
2             first self-pinned means having a first pinned layer, a first spacer layer and a first  
3     free layer;  
4             a second self-pinned ~~GMR sensor~~ means having a second pinned layer, a second  
5     spacer layer and a second free layer; and  
6             means, disposed between the first free layer of the first self-pinned means and the  
7     second free layer of the second self-pinned means, for biasing the first and second ~~pinned~~  
8     free layers of the first and second self-pinned means to provide antiparallel  
9     magnetizations for the first and second free layers without using an antiferromagnetic  
10    layer.